4.0 C.U.R.E. MAJOR WORK SUMMARY

4.1 GENERAL DISCUSSION

During Plant Clean-up, a fire erupted at P-1165A resulting in significant damage to piping, instrumentation, electrical & lighting, motors, structural concrete and steel in the vicinity. The air cooled heat exchanger E-1100 A&B cells and associated structural steel failed in the fire and were destroyed as well.

Project CURE (Crude Unit Rebuild Effort): Following the fire, two teams were assembled: an Assessment Team focused on assessing the damage, and a Project Team focused on the rebuilding of the Plant. Many members of the Assessment Team transitioned to the Project Team as assessment work was completed. The Assessment Team was lead by Peter Risse; the Project Team was lead by Marc Evans. Marc Evans also had oversight of the Assessment effort as well. Once the Assessment was completed, Marc Evans took overall ownership of the Project. The following Assessment Teams (Leads) were assembled: Piping and Mechanical (Dan Mason, Brian Blomquist), Machinery (Alan Lowell), Instrumentation (Ed Burghardt), Electrical (Jamie Cabrera), and Civil Structural (Tom Farr).

All Procurement activities were handled by the Capital Projects Procurement Staff (Alice Smith). All material was ordered through Ariba. Using Ariba resulted in a delay of a couple days between submission of a Material List and the receipt of a Purchase Order to place within the Piping EWO's. Consequently, Purchase Orders were not included in the EWO's; instead, Purchasing requested that Vendors package and tag all material by EWO number and kept a running log of Purchase Order versus EWO so that Receiving and Maintenance could track material orders. As is usually the case on rush projects such as this, materials tracking and retrieval was an issue. We also experienced problems with the Contractor's ability to keep track of material they picked up from Receiving at No.8 Warehouse.

The following is an account of the incident.

On January 15, 2007, a fire erupted in the vicinity of the Vacuum Bottoms Pump P-1165A at the No. 4 Crude Unit. There were no serious injuries and the fire was quickly extinguished.

Feed was pulled from the Crude Unit shortly after midnight on January 15; Plant clean up was proceeding well per plan. Washoil had been introduced to front end of the Unit and was being systematically fed throughout the Unit. Furnace fires were out, and the C-1160 Vacuum Bottoms temperature was 230°F.

A level had accumulated in the bottom of the C-1160 Vacuum Distillation Column. An Operator went to start the P-1165A Steam Turbine Driven Vacuum Bottoms Pump, P-1165A to pump down the level. With him were two trainee Operators.

At approximately 5:18 AM, as P-1165A was brought on-line and discharge pressure increased, the 4" washoil header spool off the P-1165A discharge failed. A mixture of vacuum residuum & washoil sprayed two of the Operators. It ignited immediately, resulting in first aid burns to one Operator, and a skin irritation to another.

Emergency response was initiated immediately and at 5:33 a.m., a Level 3 Alert / Shelter-In-Place was initiated for the Community, Refinery, and the Energy Technology Company (ETC). The fire was brought under control and the "All Clear" was announced at 8:40 a.m. Several small fires were left burning in a controlled manner until all fuel was exhausted at approximately 2:15 p.m.

Incident investigation team was formed and the event was investigated. For a complete list of investigation findings, see the MITS report MITS-2007-1126.

The failed washoil spool – 12" long roll-out spool between two block valves -- was analyzed. Metallurgical testing and analysis indicated sulfidation corrosion thinned the wash oil spool. It was also found that the upstream gate valve (5 Cr body, 300#) had no valve seats, allowing flow to bypass the valve.

In the original design, there is a pipe specification break at the first block valve off the pump discharge piping. The specification changes from an ASME 300#, 5Cr-1Mo to an ASME 150#, Carbon Steel specification. The spool was intended to be disconnected when not in service; this has not been the practice in the Crude Unit for many years.

As a result of the Investigation, thirteen valves off pumps in similar service to the 5Cr-1Mo valve at P-1165A were replaced. Additionally, the second gate valve (150#, CS) on these washoil spools were replaced with ASME 300# Carbon Steel gate valves at these pumps. In the Washoil Header off P-1165&A, a restriction orifice and PSV were installed to protect the balance of the Washoil Header from over-pressure caused by P-1165&A. Section 4.3 of this Report for a detailed description of the work done in response to the Investigation Findings.

4.2 ASSESSMENT

Initial assessment was hampered due to restricted access to the Plant. Access was restricted due to safety / exposure concerns, the need to secure the Plant operationally, and the need to preserve the fire zone for Chevron and OSHA

incident investigation. In the days following the fire, access in the area around P-1165A continued to be restricted.

Using the guidelines from API-579 "Fitness for Service", Section 11 "Assessment of Fire Damage", the following Fire Zones were developed from forensic evidence in the fire area and Fire Zone Plot Plan Maps were created. These Fire Zone Maps were then used to determine the type and extent of inspection to be done. See Attachment 4-1,'P-1165 Event Fire Zone Cheat Sheet'", that was used as a guide for determining Fire Zone classification and determining what work needed to be done based on forensic evidence observed. It is a gross summary of the information presented in Table 11.1 through 11.7 in API-579.


Att 4-1 Fire Zone Cheat Sheet.doc

The Fire Zone Maps broke the fire area into the following zones. Zones 1 & 2 were omitted from the maps because the consequences are mild and require only cleaning / water-washing.

Zone 3: Temperature during the fire in this zone ranged from 150°F to 400°F.

Zone 4: Temperature during the fire in this zone ranged from 400°F to 800°F.

Zone 5: Temperature during the fire in this zone ranged from 800°F to 1,350°F.

See Attachments 4-2, 4-3, and 4-4 for Fire Zone Plot Plan Maps at Grade Elevation, 16 ft above Grade, and 43 ft above Grade, respectively.


Att 4-2 Fire Zone Map @ Grade.doc


Att 4-3 Fire Zone Map @ 16 ft.doc


Att 4-4 Fire Zone Map @ 43 ft.doc

4.2.1 Piping / Mechanical Assessment

Once the Grade Level Fire Zone Map was created, an assessment of long lead piping material was made; also included was an assessment of PSV's in the area and shrouds / mechanical parts needed for the E-1100 A&B Fin Fan Heat Exchangers. Note: The E-1100 tube bundles were on-site as bundle replacement had been planned as part of the Shutdown scope.

Using the Inspection Isometrics and the Fire Zone Map, an estimation of alloy piping needs was made in advance of detailed inspection / assessment; alloy piping – including the Vacuum Furnace Transfer Line material – and PSV's were purchased. As the piping assessment work

progressed it was determined that very little of the 5Chrome piping and none of the Stainless Steel piping required replacement. This material was purchased in advance of any piping inspection efforts.

Once access was granted, Inspection began piping assessment, writing TAW's for insulation removal for hardness testing and dye penentrant testing of stainless steel components. Any piping that was visibly distorted was written up for replacement. Aside from one 5Chrome piping weld in the P-1165A discharge line, no hardness or cracking issues were noted. One 5Chrome weld was determined to have hardness greater than 235BHN and required PWHT. It was suspected that during original construction, the PWHT was not performed properly.

The first step in the fire damage assessment was to identify and make a hard copy of approximately 437 inspection piping isometric drawings of systems which were mostly hydrocarbon services. A spreadsheet was developed to determine and track the status of each line (see Attachment 4-5, "Piping and Vessel Assessment").

Att 4-5 Piping and Vessel Assessment Sp

The spreadsheet was color-coded showing lines requiring replacement as RED. Lines inspected and found fit for service were listed as GREEN. The spreadsheet link was maintained in the CURE project database.

We were initially allowed a quick fire damage assessment of the Unit which allowed us to identify what area of the Unit was affected by the fire. This was helpful as it allowed us to shorten the list of lines requiring inspection. We basically printed out a copy of each isometric drawing in the Unit and determined if it was located in the direct vicinity of the fire.

Approximately 224 drawings were not affected and excluded from the assessment. Visual inspection removed another 134 drawings from the list. This left approximately 80 drawings requiring a more detailed inspection.

Isometric drawings did not exist for most of the utility piping. Pipeway section drawings were created at pipe support 11J-18 in the East/West Pipeway and at pipe supports 11-H1 & 11-F1 in the North/South pipeways. This helped identify most lines passing through the immediate fire zones. Hand-sketched isometric drawings were generated by Designers for the utility piping systems because they didn't originally exist. Approximately 50 hand-sketched utility drawings required inspection. Many of these sketches had multiple lines on them.

A team of Inspectors visually inspected a total of 128 lines and sketches. Recommendations (TAW's) were created in the Impact TA database under the file 1Q07 CRUDE UNIT RECOVERY-CURE. A total of 99 TAW's were written for staging, insulation removal, demo and/or repairs. Engineering Work Orders were created for all piping replacements based on Inspection generated TAW's. Roughly 50 line drawings or sketches required some form of replacement (some sketches had multiple lines on them). Meridium history briefs summarizing the findings and repairs were written on each asset inspected.

Hardness testing and stainless steel PT inspection criteria was developed with input from the Refinery Materials Engineer. Carbon steel piping hardness was deemed acceptable if found below 200BHN; Low Chrome piping hardness testing was deemed acceptable if found below 235BHN. Systems requiring hardness testing were those in Fire Zone 5 that were not insulated or the insulation was burned off. For carbon steel systems, three tests were taken on each circuit on the base material and fittings. Low Chrome required testing every 10 feet including each fitting. For both carbon steel and low chrome system, hardness tests were taken on the HAZ, weld cap and HAZ at each location on both the fire and cool side of the object.

Random PT inspection of stainless steel systems was completed due to concerns of DWOP water causing chloride SCC. The piping systems and PT inspection results was documented on the above spreadsheet.

The 50 psi Steam Knock-Out Drum, V-1164, was the only pressure vessel in Fire Zone 3 or above. A small section of insulation was burnt exposing three square feet of the carbon steel shell. Hardness tests results were below 200BHN so the only repairs required was insulation replacement.

Valves severely affected by the fire were replaced. Operations generated a valve repair list. Valves, flange bolting and gaskets were serviced or replaced in Fire Zones 4 and 5. Those in Fire Zone 5 were obvious replacements and those in Fire Zone 4 were replaced based on appearance and operability. Instrumentation and tubing replacement was handled by the Instrumentation Team.

4.2.2 Machinery Assessment

Using the Fire Zone Maps, an assessment was made for machinery -- basically pumps and motors. All motors in the Crude unit were uncoupled and solo ran to determine condition using on-line diagnostics and meggering. Motors that were significantly heat or water damaged from the deluge system were replaced. Other motors were cleaned and

baked if they meggered low. In all, 31 new motors were purchased and 17 were repaired.

For the pumps, machinists checked rotation, oil condition, couplings and for any signs of visual damage. Any problems were corrected. See attached spreadsheet (Attachment 4-6, "Motors & Machinery Assessment") for general workscope. All pumps in 4 Crude received visual inspection and oil change as a minimum during inspection. The attached spreadsheet (Attachment 4-6) details the assessment of pumps and motors as well as which equipment had no work, repaired or replaced. There were seven pumps pulled and repaired. Work done on TP-1165A is described in detailed below in Section 4.5.

Att 4-6 Motor and Machinery Assessmer

4.2.3 Electrical Assessment

The assessment team was comprised of Jaime Cabrera, Bobby Siebenrock, Steve Cavalli, and Kenny Helton (Pascagoula Refinery). After the Fire Zone maps was distributed to the Assessment Team, they were used to determine that any electrical equipment, including, but not limited to, raceways, wire, motors, transformers, lighting panels, lights, and outlets that were subjected to Zone 4 would be replaced. All equipment in Zone 3 would be inspected and assessed individually to determine the need for replacement. A decision was also made to replace all 480volt motors that were 200hp and below due to their exposure to the deluge water system and/or overspray of fire water. Some of the larger hp motors rated 2300volts that tested poorly were sent to three different motor shops and for inspection and reconditioning. The reconditioning process consisted of opening the casing and checking for winding insulation integrity or deterioration thereof, and moisture build-up. They were then cleaned, dipped, baked, and re-painted.

The solution for repairing damaged motor, control, branch circuit and services feeders was to intercept the feeder in a location that was well out of Zone 3 area and use ("in-line") splicing materials. This is consistent with industry practice on such long feeder runs. After the splices were installed the feeders were tested for insulation integrity and then terminated.

The attached document (Attachment 4-7, "Electrical Equipment Assessment") was used to perform the damage assessment for all D&R equipment that has an asset description and identification number. Unaffected equipment is shaded in gray while bold represents affected equipment.

Att 4-7 Electrical Equipment Assessmer

The attached document (Attachment 4-8, "Conduit and Wiring Assessment") was also used for assessment and pertained to all other affected equipment that did not have an asset description or an ID number. This document was also used as a QA/QC checklist.

Att 4-8 Conduit and Wiring Assessment.xl

4.2.4 Instrumentation and Analyzer Assessment

Using downloads of the bad I/O points on the DCS and an instrument Location Drawing overlaid with the Fire Zones, a scope of work was determined. The most significant damage was done to the "home-run" cable tray system directly below the E-1100 A& B Fin Fans catwalk.

Home run cable replacement alternatives were discussed with Operations, Maintenance, Engineering, and on-site Construction Specialist. Installing junction boxes at a location where cables were in good condition was selected as the best solution to restore connection between the field and DCS.

All control valves and transmitters in Fire Zone 5 were placed on order for complete replacement. Other soft and plastic parts on instrumentation were identified in a larger area around the fire. One surprise was the temperature multiplexing panel 11TJB02. From the outside the panel looked to be in good shape, but when opened, fire damage on the inside of the panel was found. The paper documentation (panel termination schedule) in the panel had combusted due to auto-ignition. Everything in the panel was replaced.

Control Valve 11FV089 Valve Body was found to have cracks on the bonnet flange. All crack indications were removed using an end mill at the Machine Shop. The surface was restored using weld procedure WPS-32 and stress relieved (5Cr-1/2 Mo). The weld repair was covered under EWO BC603-E1,

Conduit routing plans are not used for instrumentation in the refinery. Therefore it was critical that the conduit and cable replacement work in the fire damaged area be a direct replacement of one section, one conduit at a time.

4.2.5 Civil Structural Assessment

Reinforced concrete was assessed by visual assessment, assessed by using a Schmidt hammer and assessed by using a standard claw hammer to determine if concrete had been damaged during the fire. If concrete sounded hollow when tapped with a hammer, the damaged concrete was removed and replaced. Some of the concrete on reinforce concrete structures in Zone 5 was replaced. This included beams and columns from the ground to the top of the concrete structures in Zone 5. In no case was an entire beam or column cross-section replaced; just a portion of a given cross-section was replaced.

Structural steel was assessed by visual assessment and assessed by performing a Brinnell Hardness Test. All the structural steel (with a few exceptions) in Zone 5 from the ground to the top of steel structures in Zone 5 was assessed to be damaged and required replacement. See Attachment 4-9, "Civil Structural Assessment", for more details on the structural steel assessment.

Att 4-9 Civil Structural Assessmen

The four most east structural steel columns on the north side directly supporting the eastern most fin fans on the pipe way were replaced with new structural steel. Also, the four most east structural steel columns on the south side directly supporting the eastern most fin fans on the pipe way were replaced with new structural steel. Prior to the fire, these eight columns were fireproofed. The eight new steel columns were fireproofed.

4.3 MECHANICAL & PIPING WORK

The E-1100 Cells A1/A2 and B1/B2 were destroyed in the fire. Fortunately, the Shutdown had planned to replace the tube bundles anyway and had bundles on-site. The Cure Project ordered three sets of Shrouds and Mechanical Equipment from Hudson; new motors were also supplied by the Cure Project.

The following piping work was performed as a result of the Fire Damage – the work scope was set by field walking all Inspection TAW's (Turnaround Extra Work – written in the Turnaround Database) and working with Inspection to determine the extent of the piping replacement on each TAW. Engineering Work Orders were written to cover all replacement work agreed upon between Inspection and Engineering. The EWO numbering system used was based upon the System Numbers identified on the Inspection Piping Isometrics. One hundred and thirteen (113) lines were replaced. Of those lines, forty two (42) were steam trace supply lines.

Piping EWO's were tracked by TAW Number. See Attachment 4-10, "EWO Tracking Spreadsheet", for a listing of all EWO's written for piping work. The spreadsheet includes all EWO's, but there could be a more current revision for a given EWO because EWO tracking became somewhat lacks toward the end of the Project.

Att 4-10 Piping EWO Tracking Log.xls

4.3.1 Vacuum Column Bottoms Piping

BC115-E1 (Insp Iso.# 0955-015-015) - The following repairs were made to P-1165 and P-1165A discharge piping:

- Replaced discharge gate and check valves.
- Post Weld Heat Treated one (1) existing pipe weld on P-1165A discharge pipe.
- Replaced ¾" warm-up line for P-1165A and added warm-up line for P-1165.
- Revised ¾" lines to allow installation of the IMPACT purchased diaphragm type pressure transmitters for auto-start.
- Reposition a clamp-on pipe shoe that had slipped out of position.
- Replace two spring hangers (11-SH-111 and 112).
- Replaced Insulation and steam tracing.

The first revision of Initial inspection recommendations (TAW-6546) included replacement of P-1165A discharge piping. After a reevaluation of the discharge piping that included hardness testing it was determined that this piping did not require replacement (TAW-7039) after all.

BC115-E6 (Inspection Iso.# n/a) - P-1165 and P-1165A pump alignment was very time consuming and included a "dry wash" procedure for the pump suction flange to improve allignment and a lot of hanger and support adjustments.

4.3.2 P-1165/A Lube Oil Piping

BC115-E2 (Inspection Iso.# n/a) – All of the damaged carbon steel lube oil skid piping for TP-1165A was replaced with 304SS. All of the existing 304 SS pipe and fittings were re-used except for instrument root valves which were replaced.

BC115-E3 (Inspection Iso.# n/a) – Replaced damaged Mist Oil Piping for P-1165 and P-1165A. Made some piping corrections to conform to present standards, including take-offs from top of sloped header and drain at end of header.

BC115-E4 (Inspection Iso.# n/a) – Replaced damaged lube oil supply piping for P-1165, P-1165A and the Mist Oil Generator. A 2" valve and flanges were added to facilitate replacement. Water did show up in the P-1165A lube oil reservoir during commissioning. This implies that the nitrogen blow after hydrotest that was requested in the EWO did not occur, or was insufficiently performed to remove water.

4.3.3 Relief Piping

BC119-E1 (Inspection Iso.# 0955-019-001, 0955-019-018, 0955-019-023, 0955-019-031, 0955-035-008 – Replaced damaged portion of 10" relief header, miscellaneous damaged vent lines that enter the header and the Fuel Gas Purge Piping. Flanges were added to facilitate hydrotest. No longer used vent piping that came from the east side of the furnaces was dismantled and not replaced. There are still portions of the furnace vent piping that were air gapped and abandoned in place – these portions should be scheduled for future dismantling.

BC119-E2 (Inspection Iso.# 0955-019-033) – A dummy leg and blind flange replaced a fire damaged section of pipe that was previously a dead leg off of the P-1105/A pump case vent piping. The dead leg was eliminated. Steam tracing and insulation also required repair.

BC119-E3 (Inspection Iso.# 0955-019-034) – Replaced fire damaged P-1165/A pump case vent piping with additional flange to facilitate hydrotest.

4.3.4 Pump-Out and Wash Oil

BC124-E1 (Inspection Iso.# 0955-024-010, 0955-024-004, 0955-025-005) – Replaced fire damaged Wash Oil and Pump Out Piping including pipe supports, hangers, steam tracing and insulation for those lines. The replacement included fire related corrective actions (see Section 4.4.3 below). Corrective actions that were completed included:

- Relocating Pump Out / Wash-Oil header to east side of column 20 to provide better access to TP-1165A.
- Revised former turnout spool pieces at P-1165 and P-1165A to 5Cr 300# TF1 piping.
- Installed globe instead of gate valves on the P-1165 and P-1165A Washoil discharge spool pieces.
- Installed a restriction orifice in the common P-1165 and P-1165A discharge washoil piping to limit flowrate through new PSV in the event of a blocked outlet relief scenario.

4.3.5 #7 S/C Flush Oil System

BC136-E1 (Inspection Iso.# 0955-036-B07, 0955-036-B01) – Replaced Fire Damaged P-1165 and P-1165A #7 S/C seal flush piping including new seal flush EBVs, steam tracing and insulation. Routing revised to higher elevation and additional flanges with valves added to allow for removal and maintenance of turbine and motor. Revised valve arrangement to improve operation of seal flush system. Additional flange added in header to facilitate hydrotest.

BC136-E2 & E3 (Inspection Iso.# 0955-036-B04) – Relocated seal flush piping for P-1105 and P-1105A to avoid replacement motors electrical boxes. Add additional valves and flanges to facilitate future maintenance and hydrotest. Replaced steam tracing and insulation.

4.3.6 Fuel Gas

BC135-E1D (Inspection Iso.# 0955-035-013) – Dismantled a ¾" threaded, fire damaged, fuel gas line that was routed to instrumentation that was no longer used and abandoned. The fuel gas line was used for instrument testing.

4.3.7 Boiler Feed Water (BFW)

BC127-E1 (Inspection Iso.# 0955-027-002) – Replaced three 3" fire damaged BFW lines from F-1100A&B and F-1160 to V-1177, a drain valve, and related insulation. This was B31.1 code piping repair work.

BC127-E2 (Inspection Iso.# 0955-027-001) – Replaced a forty foot section of fire damaged 6" Low Pressure BFW piping.

4.3.8 800# Steam Piping

BC139-E6 (Inspection Iso.# n/a) – Replaced and relocated 800# steam piping at the P-1165A turbine control valve PV-065B to improve access (fire related corrective action – see Section 4.4.3 below) and replaced fire damaged equipment. Work included:

- Replaced and relocated all of the 1.5" and 1" warm-up lines, valves, and steam traps on east side instead of the west side of manifold near the TP-1165A turbine. Work included installation of additional valves for double blocked drains and PI connections.

- Replace a portion of the 6" high pressure steam turbine inlet piping and block valve. A flange was installed on the 6" steam line to facilitate hydrotest. The new portion of piping was mechanically cleaned internally to the satisfaction of machinery SME prior to installation; no "steam blow was performed.
- Add additional flanges to facilitate hydrotest.
- Three new replacement spring can supports 11-SH-361, 362 and 363.
- Installation of piping insulation.
- Turbine flange bolt-up and alignment.

BC139-E19 (Inspection Iso.# n/a) – Dismantled damaged 800# Furnace Soot Blower Steam piping that was no longer of any use. Relocated required, damaged 800# steam trap manifold from Pipe Stanchion PS20 to PS19 to improve access at P-1165A per corrective action recommendation.

4.3.9 150# Steam

BC139-E1 (Inspection Iso.# n/a)– Replaced a Fire Damaged section of the 3" Steam line with 2" piping. Three inch pipe was not required considering the line supplies a 1.5" line that provides steam for ¾" steam outs for K-1181A/B and K-1168A/B strainers.

BC139-E3 (Inspection Iso.# n/a) – Replaced a Fire Damaged section of 4" 150# Superheated Steam piping coming from F-1100A/B supplying Velocity Steam to F-1160.

BC139-E5 (Inspection Iso.# n/a) – Replaced fire damaged turbine TP-1165A exhaust piping including:
- Four inch, 8", 10" and 1.5" piping and valves.
- Additional flanges to facilitate hydrotests.
- A 4" x 6" Steam exhaust relief valve.
- Spring Hanger 11-SH-356
- Pipe shoes and anchors.
- Insulation.
- Turbine flange bolt-up and alignment.

BC139-E14 (Inspection Iso.# n/a) – Replaced fire damaged section of 1.5" 150# steam piping in pipe rack. Added flanges on each side to facilitate hydrotest.

BC139-E16 (Inspection Iso.# n/a) – A section of 1-1/2" Carbon Steel 150# Steam Line was significantly bowed toward the north, possibly due to the

fire. Replaced approximately 13 feet of 1-1/2" piping and replaced insulation.

BC139-E20 (Inspection Iso.# n/a) – Replaced damaged 1.5" Steam Trace Supply "PP" Manifold, improved valve handwheel clearances and replaced all of the required damaged steam tracer supply lines and increased their size from ½" to ¾" in accordance with current piping practice.

BC139-E21 (Inspection Iso.# n/a) – Replaced damaged Steam Trace Return "RR" Manifold, improved valve handwheel clearances, added additional drains and test connections, added an additional trap manifold as needed to complete steam tracing circuits and replaced the associated damaged condensate lines.

BC139-E22 (Inspection Iso.# n/a) – Replaced damaged 1.5" Steam Trace Supply "OO" Manifold, improved valve handwheel clearances, provided future steam trace connections in place of steam trace supply lines that are no longer required, replaced all of the required damaged steam tracer supply lines and increased their size from ½" to ¾" in accordance with current piping practice.

BC139-E23 (Inspection Iso.# n/a) – Replaced damaged 1.5" Steam Trace Supply "QQ" Manifold, improved valve handwheel clearances, replaced all of the required damaged steam tracer supply lines and increased their size from ½" to ¾" in accordance with current piping practice. Revised destination for one tracer supply line to connect with new tracer location due to dismantled section of process piping.

BC139-E25 (Inspection Iso.# n/a) – Replaced corroded section of 2" 150# steam vent warm-up piping to atmosphere.

BC109-E1 (Inspection Iso.# n/a) – Repaired steam trace circuits for P-1105/A Atmospheric Column Bottoms. Steam trace circuits were shown in detail on sketches for P-1105/A and FV-000 flow control valve manifold.

BC115-E5 (Inspection Iso.# n/a) – Repaired steam trace circuits for P-1165/A and P-1188/A Suction and discharge. Steam trace circuits are shown in detail on sketches for both sets of pumps and Vacuum Column Bottoms control valve manifolds FV-066 and FV-054.

BC119-E4 (Inspection Iso.# n/a) – Repaired steam trace circuits for P-1105/A and P-1165/A Pump Vents. Steam trace circuits are shown in detail on sketches for pump vent system.

BC124-E2 (Inspection Iso.# n/a) – Repaired steam trace circuits for Wash Oil and Pump Out System. Steam trace circuits are shown in detail on sketches.

BC136-E4 (Inspection Iso.# n/a) – Repaired steam trace circuits for 7 S/C Seal Flush System. Steam trace circuits are shown in detail on sketches.

4.3.10 50# Steam

BC139-E10 (Inspection Iso.# n/a) – Replaced fire damaged TP-1165A turbine case steam traps and associated valves and piping. The present method for keeping the turbine warm when out of service utilizes the 150# steam exhaust back feeding into the turbine case. One of the four traps had been routed to the medium pressure condensate header and the other three routed to the 150# steam header. The three traps that were routed to the 150# steam header would not normally function. CURE took the opportunity to re-route all four traps to the 50# steam header per IMI request so that they would all function normally.

BC139-E18 (Inspection Iso.# n/a) – Replaced fire damaged 50# steam piping to P-1165A gland steam quench.

BC605-E1 (Inspection Iso.# n/a) – Serviced and tested gauge glass for V-1164. Repacked gauge glass vent and drain valves.

4.3.11 Condensate

BC137-E1 (Inspection Iso.# n/a) – Replace Fire Damaged section of the 2" LP condensate line coming from V-1164.

BC139-E13 (Inspection Iso.# n/a) – A section of 6" Medium Pressure Condensate in the pipeway was inadvertently dismantled by contractor. Three 1-1/2" Laterals off this section of the header were damaged in the fire. Two additional 1-1/2" laterals that come in from steam trap manifolds at the east end of Furnaces F-1100A&B and F-1160 were out of service and partially dismantled. The following work was completed:

- Replaced section of 6" Medium Pressure Condensate header
- Replaced three 1-1/2" laterals off this section of the header that were damaged in the fire.
- Completely removed two 1-1/2" laterals from furnaces
- Installed two 1-1/2" gate valves on the Header with blinds for that are available for future use.

4.3.12 Cooling Water, Fresh Water, Drinking Water and Fire Water

BC139-E2 (Inspection Iso.# n/a) – Replaced a fire damaged section of 3" cooling water piping.

BC139-E15 (Inspection Iso.# n/a) – Replaced 3" cooling water return piping, and 2" and ¾" Cooling Water Supply & Return Piping for P-1165 & P-1165A that was damaged in the fire (fire related corrective action – see Section 4.4.3 below). The cooling water piping to/from the P-1165A lube oil cooler and to/from the P-1165A bearing housings was rerouted to widen the access path on the East side of the pump skid and to improve access to the turbine gimple (TNT) valve.

BC139-E12 (Inspection Iso.# n/a) – Replaced fire damaged 6" Fresh Water piping in pipe rack. Also replaced the fire damaged 2"and 1" lateral sections. The Utility Wash-Down station at pipe stanchion PS19 and the piping feeding it were damaged in the fire. The Wash-Down station was replaced and fed from a closer supply of fresh water.

BC139-E17 (Inspection Iso.# n/a) – Removed approximately 45 feet of damaged threaded galvanized 2" drinking water piping that did not serve a purpose and installed valve with plug at the end of the remaining line in its place.

BC139-E8 (Inspection Iso.# n/a) – P-1165&A Deluge Piping: replaced fire damaged fixed spray firewater piping including piping, spray nozzles, swivel, pneumatic instrument tubing and fusible plugs. Relocated 2" deluge header flush valve at PS-20 as a result of the corrective action to relocate Wash Oil/Pump Out manifold.

4.3.13 Utility Air, Instrument and Nitrogen Piping

BC139-E4 (Inspection Iso.# n/a) – Replaced fire damaged 1", 1.5" and 3" Utility Air piping in the pipe rack and a Utility Air Station at PS-20.

BC139-E7 (Inspection Iso.# n/a) – Replaced fire damaged 2" 100 psi Instrument Air header piping and replaced ¾" instrument air piping as needed. Installed ¾" root valves along new header piping for future instrument air take-offs.

BC139-E11 (Inspection Iso.# n/a) – Replaced fire damaged 2" 50 psi Instrument Air header piping. Also replaced the fire damaged 1" and ¾" instrument air piping that is routed to P-1165 and P-1165A.

BC139-E9 (Inspection Iso.# n/a) – Replaced fire damaged nitrogen piping that used to be in Fuel Oil service – replaced it with a new 2" header. Piping arrangement was simplified and included a single nitrogen drop at PS-20. Piping modifications allowed for better access around P-1165A area.

4.3.14 Spring Cans, Hangers and Valves

BC102-E1 (Inspection Iso.# 0955-014-005, 0955-002-021) – Replaced five heat damaged spring hangers, adjusted 4 spring hangers, and replaced one misaligned hydraulic snubber. These were supports that were not associated with specific piping replacement EWOs. Other spring cans and supports are included with their respective pipe replacement EWOs.

BC102-E4 (Inspection Iso.# 0955-015-001) – For P-1165/A suction lines, replaced one heat damaged spring can, adjusted four spring cans and replaced one sway strut.

BC102-E2 (Inspection Iso.# n/a) – Replaced and serviced numerous valves as indicated by valve lists that are part of these EWO's (two revisions to original EWO).

BC102-E3 (Inspection Iso.# 0955-002-015) – At the F-1100B Pass Flow manifolds, removed abandoned orifice tap valves, serviced or replaced in-service orifice tap valves, serviced block and bypass valves and replaced pressure gauges.

BC102-E5 (Inspection Iso.# n/a) – Replaced gasket at end of 3" cooling water header, removed one damaged 1½" flanged valve that was no longer needed, replaced 2" 150# steam valve, replaced gasket and bolts on 150# steam flange and serviced a 1.5" steam valve.

BC102-E6 (Inspection Iso.# n/a) – Replaced ¾" P-1105A discharge spool bleeder valve that was missing its seat.

BC102-E7 (Inspection Iso.# n/a) – Replaced ½" valves at steam trap manifold on west side of P-1165/A.

4.3.15 Safety Relief Valves

During the early days of assessment, before any relief valves could be disassembled and inspected, all relief valves in / near Fire Zone 5 were identified for replacement. In hindsight, this was a conservative approach, especially in the case of steam PSV's that were relieving steam during the fire; the valve bodies for such PSV's could likely have been salvaged.

The following six PSV's were purchased by the CURE Project; these PSV's were added to the Shutdown's PSV EWO and installed by the Shutdown.

Valve No.	Size	Description
C7-22	1.5"x3"	Hot BFW F-1100A to V-1177
C7-24	3"x4"	150 PSIG Superheated Stripping Steam
C7-72	4"x6"	TP-1165 Low Pressure Steam
C7-71	0.75"x1"	P-1165 Cooling Water Return
C7-73	0.75"x1"	P-1165 Cooling Water Return
C7-84	1"x2"	V-1164 Steam Knock Out Drum

4.3.16 Dismantle Abandoned Piping

BC128-E1D (Inspection Iso.# n/a) – Naphtha Return, Fuel Oil and Steam-Air De-Coking Piping: Dismantled portions of the piping and air gapped remaining piping for future demolition. Work on this EWO that was not required prior to start-up was not completed. EWO identifies abandon in place lines for future dismantling after start-up.

4.3.17 Cable Trays Fire Proofing

BC607-E1 (Inspection Iso.# n/a) – Large portions of the 36" Instrument Cable Tray (E-W P/W) and 24" Instrument Cable Tray (N-S P/W) were damaged / destroyed in the fire. After installation of the Cable Trays, Fire Insulating material was applied to both Cable Tray runs.

4.4 PIPING MECHANICAL WORK RESULTING FROM INCIDENT INVESTIGATION CORRECTIVE ACTIONS

4.4.1 Process Valves

BE168-E1 - In response to the Fire TapRoot™ Investigation A/C Recommendation #6, a field audit was performed to confirm materials of construction of the isolation valves associated with pumps in "hot oil" service. For this scope of work, hot oil was defined as process streams that exceed 500F during normal operation and have the potential to contain sulfur or H2S. The audit identified a total of eleven (11) valves with NiCu (Monel) seat material, which is not consistent with the original construction specifications or with current design specifications for this service. All eleven valves were removed and replaced with new valves equipped with trim that meets current pipe class requirements.

Following are the eleven (11) valves that were identified and replaced:

- P-1158 Discharge Pumpout Spool Primary Block Valve
- P-1159 Discharge Washoil Spool Primary Block Valve
- P-1159A Discharge Washoil Spool Primary Block Valve
- P-1178 Discharge Washoil Spool Primary Block Valve
- P-1178A Suction Pumpout Spool Primary Block Valve
- P-1178A Discharge Washoil Spool Primary Block Valve
- P-1105A Suction Washoil Spool Primary Block Valve
- P-1105A Discharge Pumpout Spool Primary Block Valve
- P-1165 Suction Pumpout Spool Primary Block Valve
- P-1165 Discharge Washoil Spool Primary Block Valve
- P-1165A Discharge Washoil Spool Primary Block Valve

The following one (1) valve was replaced because the seat material could not be positively identified:

- P-1187 Pump Suction Primary Block Valve

The following one (1) valve was replaced because the body material did not meet current pipe class requirements:

- P-1165A Suction Pumpout Spool Primary Block Valve

4.4.2 Fin Fan Support Leg Fire Proofing

In response to A/C Recommendation #7 Carboline Pyrocrete 241 Fireproofing was applied to the eight (8) vertical fin fan structural support members that were impacted by the fire. Pyrocrete 241 is designed to protect the support members from reaching 1000F for a period of three hours as recommended in Section 1722 of the Chevron "Fire Protection Manual." Pyrocrete 241 also meets the requirements in Section 6.1 of the Chevron "Design and Installation of Passive Fireproofing for Hydrocarbon Pool Fires in Onshore Processing Facilities."

See Section 4.8, Civil / Structural Work, for more information. Following are the eight (8) support members that were impacted:

- Two (2) members located immediately beneath E-1100A1 on the South side of the structure.
- Two (2) members located immediately beneath E-1100B1 on the South side of the structure.
- Two (2) members are located immediately beneath E-1100A2 on the North side of the structure.

- Two (2) members are located immediately beneath E-1100B2 on the North side of the structure.

4.4.3 P-1165A Access

In response to A/C Recommendation # 8 the following changes were made in the P-1165A area to provide improved access and revised control locations:

- BC139-E15 - The cooling water piping to/from the P-1165A lube oil cooler and to/from the P-1165A bearing housings was rerouted to widen the access path on the East side of the pump skid and to improve access to the turbine gimple (TNT) valve.

- BC139-E6 - The small bore 800# steam warmup lines at the inlet to TP-1165A were rerouted to widen the access & egress path on the East side of the pump skid.

- BC124-E1 - The Vacuum Washoil / Pumpout manifold previously located on the West side of P.S. #20 was relocated to the East side of P.S. #20 to widen the access path between the P-1165A 800# steam inlet line and P.S #20.

- A control station was installed to allow remote operation of the TP-1165A 800# steam inlet Automatic Pump Start (APS) valve as a hand control valve for turbine start-up in lieu of the gimple (TNT) valve. Level II training was performed in accordance with MOC # 16774.

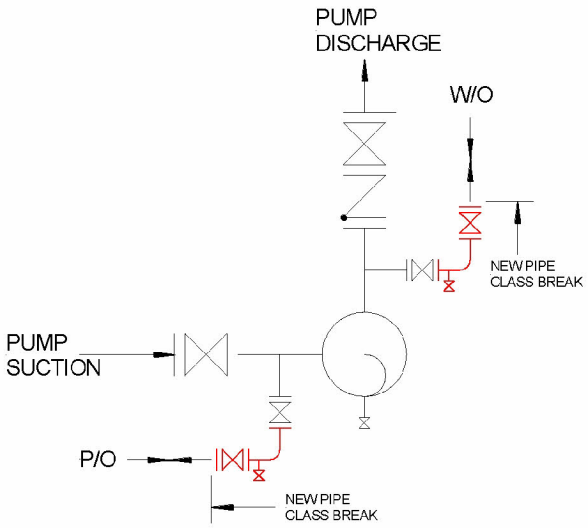
4.4.4 Vacuum Washoil Header PSV Install

BE172-E1 - In response to Fire TapRoot™ Investigation A/C Recommendation #9, a new 3" X 4" bellows style PSV (C7-148) was added to the vacuum washoil header to protect the Class 150 header from potential overpressure. No. 4 Crude Unit Operations Shutdown Procedure 4CU-NP-3050 step 2.1 instructs to "route a slip stream of washoil from the discharge of P-1165A through the washoil header into the discharge of P-1168 and P-1168A". During this operation the discharge pressure of P-1165A can exceed the washoil header pipe class pressure rating. The new PSV will provide mechanical protection to ensure that equipment is operated within design limits at all times. Additionally, a Restriction Orifice (11RO1165) was installed in the washoil header off P-1165&A to limit the flow / pressure that the PSV relieves in the event of a "blocked discharge" relief scenario.

4.4.5 Hot Oil Pump Washoil and Pumpout Spool Upgrades

BE168-E1 – In response to Fire TapRoot™ Investigation A/C Recommendations #9 and #10 the washoil and pumpout spools on all of the "hot oil" pumps were upgraded to match the respective process stream pipe classes for each pump. A total of thirty-six (36) spools were identified as being coupled to hot oil pumps. All 36 spools were replaced up to and including the second block valve. All 36 spools were upgraded to meet ASME Class 300 requirements. Twenty two (22) spools were metallurgically upgraded to 5Cr – 1/2Mo. One (1) spool was metallurgically upgraded to 9Cr – ½Mo. Thirteen (13) spools remained Carbon Steel consistent with the process piping. The intent of these upgrades was to provide full-rated double block & bleed isolation between the process and the washoil and/or pumpout headers. Additionally, these upgrades provide an inherently safe design that will allow the spools to remain in place permanently without risk of over-pressure and with reduced risk of sulfidation corrosion failure.

The schematic below outlines the typical spool arrangements. Bold red lines indicate components that were replaced/upgraded.



TYPICAL ARRANGEMENT

The Table below identifies the spools that were replaced.

Pump Equipment #	Service Description	Pipe Class	SIZE	RATING	COMMENTS
P-1139	3 S/C				
	SUCT P/O SPOOL	BB/AF2	3	300	
P-1149	4 S/C				
	SUCTION P/O SPOOL	BB/AF2	3	300	
	SUCTION W/O SPOOL	BB/AF2	6	300	
	DISCH W/O SPOOL	BB/AF2	4	300	See S/D EWO # BE121-E1
P-1158	5 S/C				
	SUCTION W/O SPOOL	BO/TF1	2	300	
	DISCH P/O SPOOL	BO/TF1	2	300	
P-1158A	5 S/C				
	SUCTION W/O SPOOL	BO/TF1	2	300	
	DISCH P/O SPOOL	BO/TF1	2	300	
P-1159A	6 S/C				
	SUCT P/O SPOOL	BO/TF1	2	300	
	DISCH W/O SPOOL	BO/TF1	2	300	
P-1179	7 S/C				
	DISCH W/O SPOOL	BB/AF2	2	150	
P-1189	8 S/C				
	SUCTION P/O SPOOL	AF1	3	300	
P-1189A	7 & 8 S/C				
	SUCTION P/O SPOOL	BB/AF2	3	300	
	DISCH W/O SPOOL	BB/AF2	3	300	
P-1178	VAC OVERFLASH				
	SUCTION P/O SPOOL	BO/TF1	2	300	
	DISCH W/O SPOOL	BO/TF1	2	300	
P-1178A	VAC OVERFLASH				
	SUCTION P/O SPOOL	BO/TF1	2	300	
	DISCH W/O SPOOL	BO/TF1	2	300	
P-1187	VAC OVERFLASH				
	SUCTION P/O SPOOL	AF2	1-1/2	800	
	DISCH W/O SPOOL	AF2	1-1/2	800	
P-1105	ATM BTMS				
	SUCTION W/O SPOOL	BO/TF1	4	300	
	DISCH P/O SPOOL	BO/TF1	4	300	
P-1105A	ATM BTMS				
	SUCTION W/O SPOOL	BO/TF1	4	300	
	DISCH P/O SPOOL	BO/TF1	4	300	
P-1148	ATM BTMS REFLUX				
	SUCT P/O SPOOL	BB/AF2	3	300	
	DISCH W/O SPOOL	BB/AF2	3	300	
P-1148A	ATM BTMS REFLUX				
	SUCT P/O SPOOL	BB/AF2	3	300	
	DISCH W/O SPOOL	BB/AF2	3	300	
P-1188	VAC BTMS REFLUX				
	SUCT P/O SPOOL	TF1	3	300	

	DISCH W/O SPOOL	TF1	3	300	
P-1188A	**VAC BTMS REFLUX**				
	SUCT P/O SPOOL	TF1	3	300	
	DISCH W/O SPOOL	TF1	3	300	
P-1165	**VAC BTMS**				
	SUCT P/O BLOCK	BO/TF1	4	300	See Cure EWO # BC124-E1
	DISCH W/O BLOCK	BO/TF1	4	300	See Cure EWO # BC124-E1
P-1165A	**VAC BTMS**				
	SUCT P/O BLOCK	BO/TF1	4	300	See Cure EWO # BC124-E1
	DISCH W/O BLOCK	BO/TF1	4	300	See Cure EWO # BC124-E1

4.5 MACHINERY WORK

The major work involved TP-1165A. A spare pump was overhauled in the Machine Shop to replace the pump damaged in the fire. A new gearbox was ordered and installed; a new gearbox could be procured faster than the existing, damaged one could be rebuilt. The old gearbox was pulled and sent to Lufkin for refurbishment and will be a shelf spare for both P-1165's. The turbine was pulled and sent to Dresser-Rand in Los Angeles for inspection and repair; NDE and hardness tests verified the integrity of the case. The rotor was damaged and a spare rotor from El Segundo was installed. The trip/throttle valve was sent to Gimpel for repair, similar NDE, and hydrotests to verify that there was no heat damage. The majority of the lube oil system was replaced and upgraded to stainless steel.

EBV's were added to the P-1165&A pump suction lines. A control interlock was added to the lube oil system to close the Gimpel valve when the suction EBV or MOV closed. The entire "train" was reconditioned including new lube oil filters, lube oil cooler, auxiliary oil pump & motor, cooling water piping, gages and controls.

During Turbine commissioning, the Carbons were broken-in, screens were installed on the steam inlet and the Turbine was run-in and over-speed tripped. The train was put in service without incident.

Six other pumps were pulled and repaired. See Attachment 4-6, "Motors and Machinery Assessment", under Section 4.2.2 for list of pumps repaired.

4.6 ELECTRICAL WORK

4.6.1 Motors

There were a significant number of motors that were either replaced or re-conditioned because they were in the Fire Zone 4, damaged by water, or due to routine maintenance reasons. See Attachment 4-6, "Motors and Machinery Assessment", from Section 4.2.2 for a tabulation of the motors that were replaced or re-conditioned.

4.6.2 2400volt Motor - Power & Control Feeders

Three (3) 2300volt motor feeders along with their controls were spliced near column stanchion #17 under the fin fan decking. The feeders and conduit in Zone 4 or 5 were removed up to the nearest Zone 2 area. The following motor feeders were spliced: 1) MP-1165, 2) MP-1105, and 3) MP-1105A.

4.6.3 480volt Motor - Power & Control Feeders

Four (4) 480volt motor feeders were spliced near column stanchion #17 under the fin fan decking. The feeders and conduit in Zone 4 or 5 were removed up to the nearest Zone 2 area. The following E-1100 FIN/FAN motor feeders were spliced: 1) ME-1100A-1, 2) ME-1100A-2, 3) ME-1100B-1, and 4) ME-100B-2.

4.6.4 CEM's Building 480volt Power Feeder

The feeder to the CEM's building was spliced near column stanchion #17 under the fin fan decking.

4.6.5 Analyzer Shelter 120/208volt Power Feeder

The feeder to the analyzer shelter next to the CEM's was spliced near column stanchion #17 under the fin fan decking. The feeder is fed from power panel "11PP1-A".

4.6.6 Dry Type Distribution Transformer Replacement

A total of three dry type transformers were replaced for panels: one 30kva for each '11LP-A" and "11RP-A" and a 15kva for "11EP-B".

4.6.7 Lighting Panel Replacement

The lighting panel '11LP-A" was replaced with an Electrical Class1 Div. 2 type panel.

4.6.8 100watt HID Light Replacement

All damaged area lights were replaced with 100watt, high pressure sodium, 208volt rated lights.

4.6.9 Start/Stop & HOA Control Stations

All control stations and associated appropriate indicating lights for the following motors were replaced: 1) MP-1165, 2) MP-1126A, 3) MP-1105, 4) MP-1105A, 5) MP-1188, 6) MP-1188A, 7) MP-11228, 8) MP-1188A, 9) ME-1100A-1, 10) ME-1100A-2, and 11) ME-1100B-1.

4.6.10 Branch Lighting, Power and Receptacle Circuits

As per Attachment 4-8, "Conduit and Wire Assessment" spreadsheet (see Section 4.2.3), Tag Numbers B-3, B-4, B-5, B-6, B-7, B-9, B-10, B-37 and B-38 were all branch feeders running through the Fire Zone 4 and 5 from stanchion #17 to #20. A re-route was taken to avoid a construction delay due to the vast concrete repair work at Column Nos. 19 and 20. The route chosen was to go from Column No. 17 (north column) and head south over to the undamaged cantilever section away from MP-1165/A just under the fin fan decking. These branch feeders feed furnace F-1160 and F-1100A lights and plugs, as well as furnace control panel PLC's. In addition, power to the radiation detectors on C-1160 decks #3 and #5 were also repaired using splices.

4.6.11 Drawings Modified

The following Electrical drawings were modified as a result of the CURE project:

B-220554	Lighting Panel Schedule - VOID
D-357147	Lighting Panel Schedule - New, replaced B-220554
D-334541	Elementary Diagram
D-334542	Elementary Diagram
C-334823 Sht. 3	Connection Diagram
C-334823 Sht. 5	Wiring Diagram
D-348269	Electrical One Line Diagram
D-348270	Electrical One Line Diagram
D-348273	Electrical One Line Diagram
D-348274	Electrical One Line Diagram
D-348277	Electrical One Line Diagram

4.7 INSTRUMENTATION WORK

4.7.1 Home-run cable replacement

Replacement of cable tray and cables was done as an in-kind replacement. Twelve new junction boxes were mounted with access from the fin-fan catwalk between E1100D and E1100E. Fire protection insulation was reinstalled on the cable tray and the new junction boxes.

4.7.2 Instrumentation validation and loop checks

After the cabling was replaced to the DCS, a communication loop check was done with every device on all the effected cables. All transmitters and valves were confirmed to operate from the DCS.

4.7.3 304SS tubing

Replaced all the instrument impulse tubing that would see elevated temperatures during operation and was exposed to fire water. Stainless steel cracking failures are possible after these situations.

4.7.4 Control Valve repairs

About 20 fire affected control valves were replace or rebuilt. A plan to test the questionable valves in-place failed and all suspect valves were pulled and set to the shop for testing. This lead to the damage of many valve parts due to the rough handling of heavy control valves with "soft" parts attached to them. A more diligent effort to test the valves in-place would have saved most of this unnecessary work.

4.7.5 Temperature Multiplexer panel

The complete 11TJB02 panel was stripped, cleaned, and rebuilt. About 360 temperature measurements are collected in this panel and sent back to the DCS. While replacing thermocouple extension wire around the furnaces, it was discovered that insulation on the wires for some conduits had completely burned off due to the high temperatures the conduit see as it is presently installed. This was completely unrelated heat damage from the fire. These failures will repeat unless the existing conduits are rerouted out of very hot areas.

4.7.6 DCS Rack Room Work

During the fire, the cables were damaged to the point that only the copper wires remained. This shorting of all the outputs on a FTA led to the

failure of many of the Honeywell analog input card limiting resistors. The cables between the FTAs and the IOP should have been pulled as soon as possible to prevent this added failure mode. About 20 FTA card had to be replaced due to this.

4.7.7 Analyzers

The CEMS analyzer sample tubing bundles for Furnaces F-1100A and F-1160 were fire damaged and replaced with new sample bundles. These bundles were ordered long to assure that they would span between the sample point high on the stack and the analyzer shelter at grade. This added length required the use of two internal sample bundle heaters per bundle instead of the expected one, and therefore, two extra temperature control circuits, one for each sample bundle, that were designed by Chevron I&E Engineering and constructed by Newtron.

4.7.8 Drawings Modified

The following Instrumentation drawings were modified as a result of the CURE project:

Connection Diagrams:

D-302998	Junction Box 11IJB22A
D-302999	Junction Box 11IJB21A
D-303000	Junction Box 11IJB23A
D-303011	Junction Box 11IJB07
D-302993	Junction Box 11IJB08
D-302994	Junction Box 11IJB09
D-302995	Junction Box 11IJB10
D-313208	Junction Box 11IJB11
D-313215	Junction Box 11IJB13
B-334460	Junction Box 11IJB20A
D-334465	Junction Box 11IJB06
D-337562	Junction Box 11IJB19A
B-353700	11IJB19/11IJB20 - Instrument Junction Box
D-353698	11IJB22 - Instrument Junction Box
D-337557	Junction Box 11IJB14A
D-338849	Junction Box 11IJB01
D-338315	Junction Box 11IJB27A
D-338271 Sht. 1	LLMUX 11TJB01
D-338271 Sht. 2	LLMUX 11TJB01
D-338272 Sht. 1	11TJB02A LLMUX TEMP. Junction Box
D-338272 Sht. 2	LLMUX 11TJB02A
D-338272 Sht. 3	LLMUX 11TJB02A
D-338272 Sht. 4	LLMUX 11TJB02A

D-338272 Sht. 5	LLMUX 11TJB02A
D-338272 Sht. 6	LLMUX 11TJB02A
D-338272 Sht. 7	LLMUX 11TJB02A
D-338314	Junction Box 11CJB04
D-338316	Junction Box 11IJB28A
D-338320	Junction Box 11IJB15A
D-338321	Junction Box 11IJB25A
D-338850	Junction Box 11IJB02A
D-338851	Junction Box 11IJB03A
D-340763	Junction Box 11OFP01A
D-340764	Junction Box 11OFP02A
D-340765	Junction Box 11OFP03A
D-353691	11OFP01/11OFP02/11OFP03 - Junction Box (FSC)
D-353692	Junction Box 11IJB01A
D-353693	11IJB02 - Instrument Junction Box (FSC)
D-353694	11IJB03 - Instrument Junction Box (FSC)
D-353695	11IJB15 - Instrument Junction Box
D-353696	11IJB14/11IJB25 - Instrument Junction Box
D-353697	11IJB21 - Instrument Junction Box
D-353699	11IJB23 - Instrument Junction Box
D-353701	11IJB27/11IJB28 - Instrument Junction Box
D-353702	11TJB02 - TEMPERATURE Junction Box
D-335335	11TJB02A TEMP. Junction Box

Instrumentation Plans:

D-333577 Sht. 1	Junction Boxes, Cable Tray and Conduit
D-333577 Sht. 2	Junction Boxes, Cable Tray and Conduit
D-335309	Instrument Location
D-335323 Sht. 1	Instrument & Junction Box Locations
D-335323 Sht. 2	Instrument & Junction Box Locations
D-335323 Sht. 3	Instrument & Junction Box Locations
D-335323 Sht. 4	Instrument & Junction Box Locations
D-335323 Sht. 5	Instrument & Junction Box Locations
D-335323 Sht. 6	Instrument & Junction Box Locations
D-335332	Junction Boxes, Cable Tray and Conduit

In addition to the above drawings, approximately 770 Instrument Loop Diagrams were also modified as a result of the CURE Project.

4.8 CIVIL / STRUCTURAL WORK

The damaged reinforced concrete was repaired with SikaTop 111 Plus and SikaTop 123 Plus. Most of the concrete repairs were done by forming and pouring SikaTop 111. Damaged concrete and all bond-inhibiting materials were

removed from the surface. Forms were installed and the SikaTop 111 was poured. SikaTop 111 Plus was used for damaged concrete in the thickness range of 1.5 inch to 5 inches.

For SikaTop 123, damaged concrete and all bond-inhibiting materials were removed from the surface. SikaTop 123 Plus was hand packed (scrubbed) into the substrate, filling voids. SikaTop 123 Plus was used for damaged concrete in the thickness range of 0.25 to 1.5 inches.

Bonding agent Sika Armatec 110 EpoCem was used with SikaTop 111 and SikaTop 123. For SikaTop 111 and SikaTop 123, conditioning of the materials and curing of the materials at around 65 degrees F is important. J. T. Thorpe & Son, Inc. of Richmond, CA did the repair work. SMITH-EMERY COMPANY provided inspection services. For more information, see Attachment 11, "Sika Armatec & SikaTop Product Data Sheets".


Att 4-11A Sika Armatec 110 EpoCem


Att 4-11B SikaTop 111 PLUS.pdf


Att 4-11C SikaTop 123 PLUS.pdf

The structural steel that was damaged in the fire was replaced in kind. That is, if a steel member was damaged in the fire, it was replaced with a new member that is the same size as the member that was damaged in the fire. All the structural steel (with a few exceptions) in Fire Zone 5 was assessed to be damaged and required replacement, including damaged steel supporting some E-1100's Fin-Fan exchangers, damaged ladders, and damaged platforms. A new Structure and Platform was installed along the cat walk under the Fin-Fins to provide access and support for the new junction boxes. AMT and XKT fabricated the new steel. P2S, Haskell, Bigge, and Timec erected the new steel. Haskell provided construction supervision and Smith-Emery Company provided inspection services.

The E-1100's structural steel columns 35A, 35B, 36B, 37B, and 38B were fireproofed using Carboline Pyrocrete 241 U.L. Design XR-702 (see Attachment 12, "Carboline Pyrocrete 241 Product Data Sheet", for a description of an XR-702 design). These wide flange columns were wrapped with a galvanized metal lath. One and one-half inch of Pyrocrete 241 was trowelled on to the lath.


Att 4-12 Carboline Pyrocrete 241.pdf

Structural steel columns 36A, 37A, and 38A were formed and poured using Carboline Pyrocrete 241. A form was built around the wide flange columns and Pyrocrete 241 was poured into the form encasing the entire wide flange column including the web of the column. The thickness of the Pyrocrete was 2" minimum at the column flanges; it is much thicker at the web of the columns.

Although this type of installation is not ideal and does not conform to a UL design, consultation with the products technical representative, Rich Hailey, revealed that the degree of fire protection was probably achieved, however no testing was done. Since the Pyrocrete is much thicker than it should be in the web of the columns and there is no reinforcement material in the Pyrocrete, there is a concern that the Pyrocrete could spall off over time, compromising the degree of fire protection and posing a danger to personnel below.

See Attachment 13, "E1100 Structural Steel", for the location of the columns.

Att 4-13 E1100 Fin Fan Structural Steel.c

J. T. Thorpe & Son, Inc. of Richmond, CA did the fireproofing work. SMITH-EMERY COMPANY provided inspection services.

Recommendation: On the E-1100 A&B Structural Steel Columns 36A, 37A, and 38A, the fire proofing material should be removed and reapplied using the method outlined in a UL XR-702 design (See Attachment 13), or secured to the columns in some fashion such as "sandwiching" the Pyrocrete between steel plates held in place with bolting.